herbarium between the New England Botanical Club and the Gray Herbarium, and for the gift of his botanical library and correspondence and his collection of portraits of botanists to the latter. There was a bequest of one thousand dollars to the Club and twenty thousand, plus the reversion of a trust fund on the death of the beneficiary, to the Herbarium. Thus he continued into the future his long service to both.

RECENT DISCOVERIES IN THE NEWFOUNDLAND FLORA

M. L. FERNALD

(*Continned from page 63*)

From Woody Point (PLATE 237) one looks back to the Canadian forest on the slope of Lookout Mountain and across to the alternately wooded and bare slopes on the opposite side of the Arm. Farther up the Arm, but standing some miles to the south, is The Tableland, a flat-topped and great, seemingly naked block of serpentine (2336 feet high), weathered pinkish- to yellowish-ochre and looking like a gigantic pale brick wall, only streaked down its side with lines of white snow-fields. Lesser rounded knobs lie between it and the "bottom" (we should say the head) of the Arm and, towering above them, like a small Matterhorn, rises the sharp pinnacle of the Peak of Teneriffe. That was our view upon landing and we were impatient to get everywhere at once.

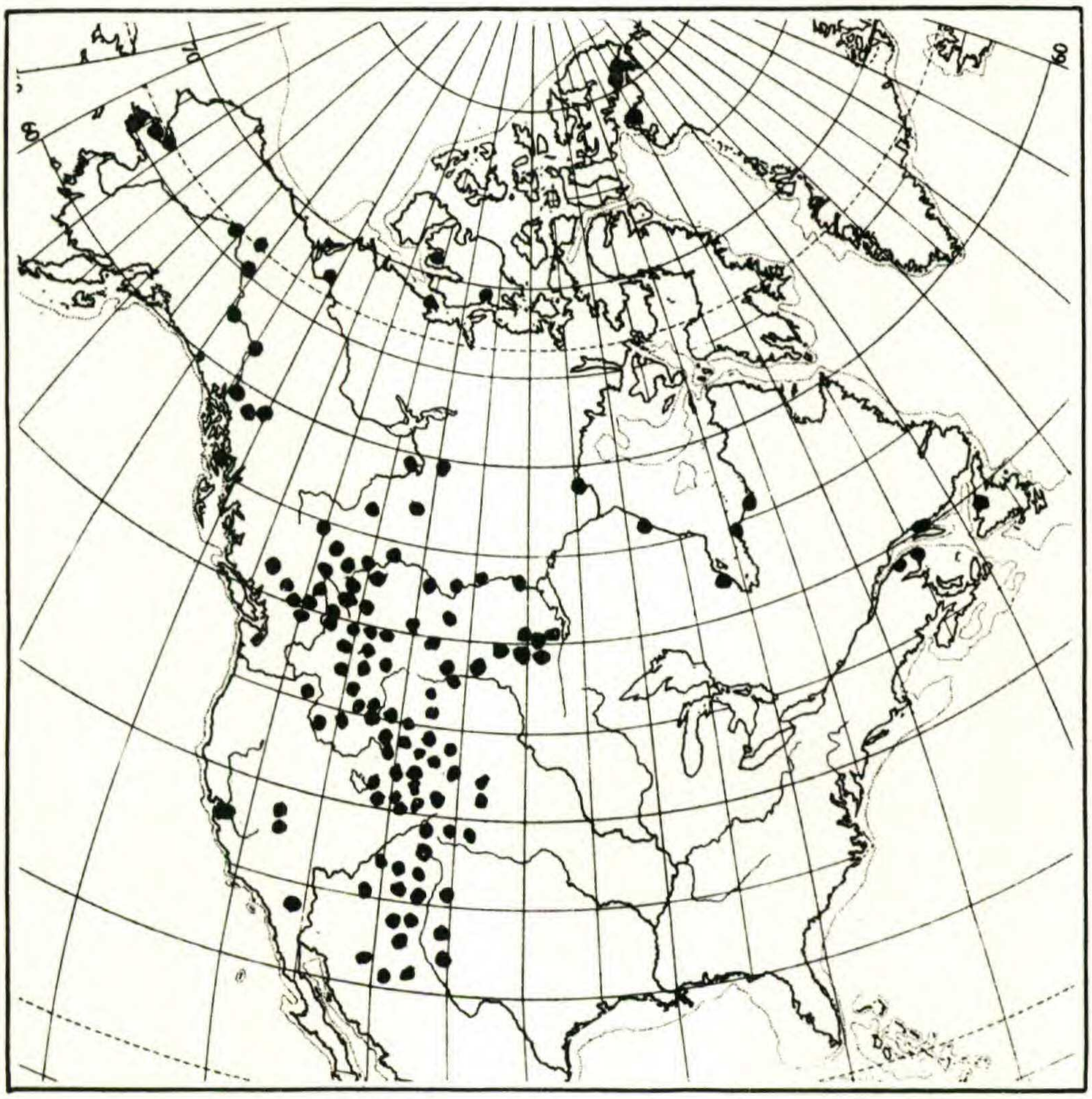
Space will not permit a detailed account of the daily knee-jolting trips and the thousand-and-one incidents of our stay at Bonne Bay. We soon discovered that it was as little "worked out" as Bay of Islands, Old Port au Choix and the dozen other areas along the West and Northwest coast of Newfoundland visited by the party of 1925. Mr. Preble promptly adopted us; and with him in his motor boat, and with a liberal supply of his fresh fruits and cream and home-made cakes, cookies and pies, to say nothing of roast chickens, we spent every day possible, from early morning to late evening, exploring the Bay and its headlands and mountains. Off days there had to be when we were forced to stay indoors caring for the presses, drying our paper in intermittent patches of sunshine and (without openly admitting it) resting our muscles and joints after the difficult climbing. Two or three talus-slopes a day were as much as we could stand;

but, when these necessary respites occurred, our ever ready and always companionable new friend was alert to hurry us through, that we might get started on another trip. Equipped with a botanizing pick and collecting box he became a fourth member of the expedition and was soon distinguishing at sight the newly found from the already collected species of *Agrostis*, *Poa* and *Festuca*. No botanical expedition should go to Bonne Bay without invoking the aid of Mr. Preble.

Whereas the Arm where Woody Point is located (I hesitate between "South Arm" and "West Arm") has several settlements comparable with those of Humber Arm of Bay of Islands, the equally extensive Main Arm is unsettled, except for the canning-factory at Lomond; and, like the Middle Arm of Bay of Islands, its southerly side is shut in by precipitous walls, repeating almost exactly the rocks of Middle Arm: fantastically contorted strata of limestone, limy slate and sandstone. To the north, beyond the slender head of East (or Deer) Arm, the round-edged block of Gros Morne (2540 feet) dominates the horizon, flanked by a series of lesser knobs; then on the northerly side of the Main Arm come two great quartzite masses, tipped at their westerly crests by conspicuous uplifted limestone cliffs, Gallie's Head (2290 feet) and Killdevil (2135 feet), and farther to the east still others beyond our reach. The south side of the Arm is almost wholly limestone, with a regular alternation of vertical walls, flanked with high talus, and coves with flats, ponds or bogs. The names, themselves, were attractive and there was romance in making landings at Shag Cliff or Tucker's Head or at Store-house Cove, Beachy Cove and Lord-and-Lady Cove (PLATE 238).

The lower slopes of limy talus (all we had time or climbing ability to get at) were a joy. "Rock Polypody," *Thelypteris Robertiana*, Holly Fern, *Polystichum Lonchitis*, *Kobresia simpliciuscula*, *Carex scirpoidea*, *Luzula spicata*, *Salix vestita*, *Saxifraga oppositifolia*, *Dryas integrifolia*, *Potentilla nivea*, *Hedysarum alpinum*, *Rhododendron lapponicum*, *Solidago multiradiata* and *Arnica chionopappa* were so common that we thought twice before collecting them; then yielded to the temptation. *Woodsia glabella*, *Sphenopholis pallens*, *Silene acaulis* var. *exscapa* and *Lesquerella* were so local that we did not hesitate; and when, high on Tucker's Head (PLATE 238), we found two individuals of *Androsace septentrionalis* L. (MAP 5), new to Newfoundland, we hunted, vainly, for more material. Mr. Preble

insists that it is not "new to Newfoundland," for he is positive that he has seen it in abundance on Gros Morne. We are inclined to believe him; but Gros Morne still awaits botanical exploration. The subalpine grass known as *Festuca rubra* var. *prolifera* Piper (PLATE 241) abounded, here, as elsewhere in Newfoundland, characteristic of cold limy walls. In its almost uniformly simple and flexuous raceme



Map 5. American Range of ANDROSACE SEPTENTRIONALIS.

(rather than forking panicle) and in its membranaceous and awnless lemmas it has always seemed to me very different from the ubiquitous *F. rubra* of circumneutral to acid lowlands. On Bonne Bay we were so fortunate as to find some culms of the normally viviparous plant with perfect florets; these have anthers so much smaller than in *F. rubra* that in Part III I shall formally treat var. *prolifera* as a definite

species. Another grass, as characteristic of these cliffs as the *Festuca* or as *Poa glauca* and *Agrostis borealis*, is *Poa trivialis*, rather general on cool slopes or in mossy openings in Newfoundland and here certainly indigenous. With the essentially boreal species it was disconcerting to find Herb Robert, *Geranium Robertianum*, abundant. Wiegand had got it in 1910, but it is highly localized in western Newfoundland. *Antennaria* was at its best. The beautiful brown-headed novelty (PLATE 265) of the limestones of Hannah's Head and Druid's Head (on the Bay of Islands) carpeted one shelf on the cliffs of Tucker's Head (PLATE 238), while another shelf supported the white-headed plant (PLATE 268) of Penguin Head.

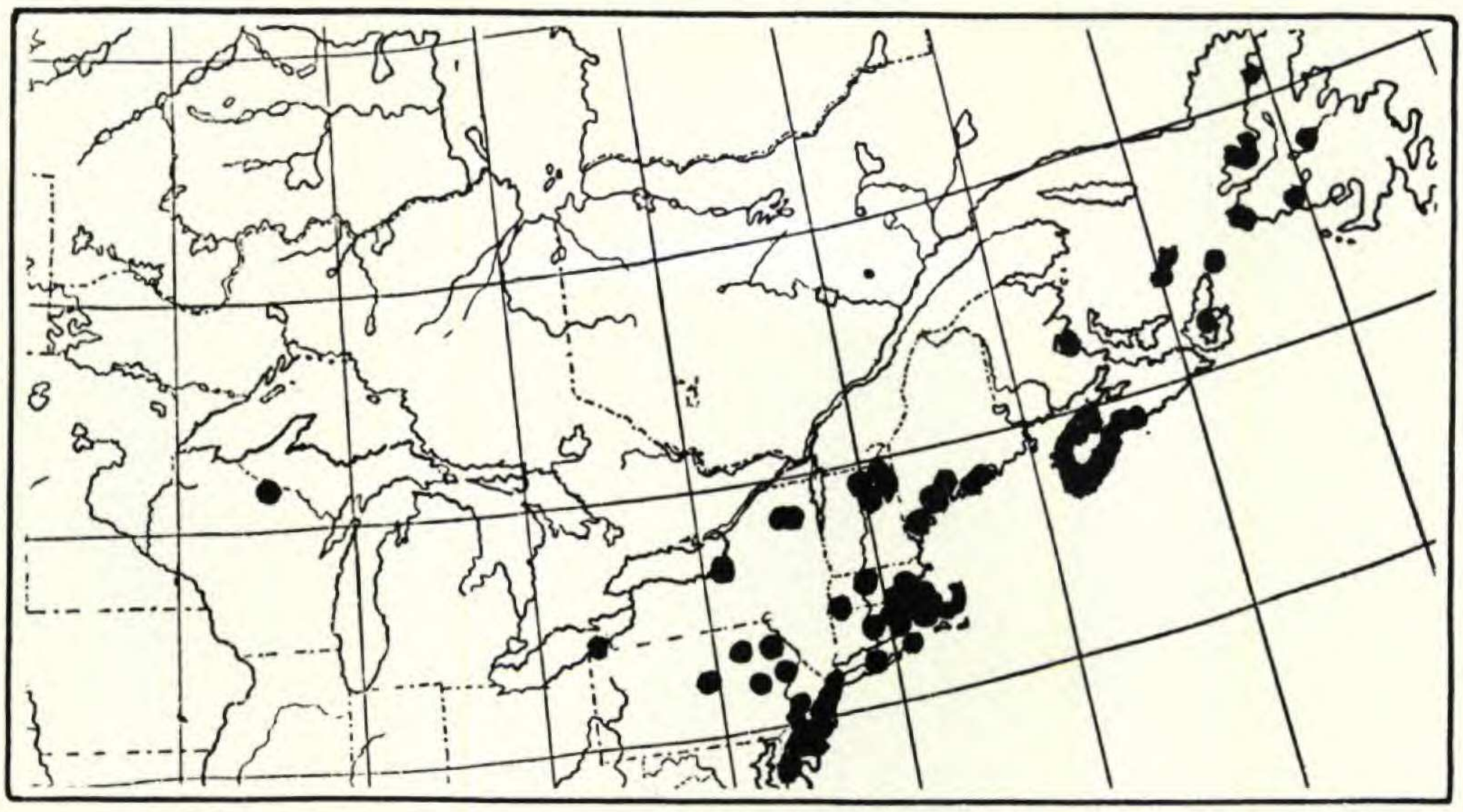
Wiegand had been on Lookout Mountain and on The Tableland in 1910; but they are such prominent features of the landscape and so emphatically contrasted with the limestone cliffs of the Main Arm that we wanted to climb them too. The day we went to The Tableland (PLATE 237) it was densely foggy in the morning, but it cleared in mid-forenoon—so clear that we ambitiously laid out a programme including The Tableland, seven miles back from the Bay, and then the Peak of Teneriffe which, deceptively, looked near-by. We got in to the northern slope of The Tableland, botanizing along Winterhouse Brook and on the lower serpentine plains, ascended by one of the snow-fields (PLATE 232) and tramped over the northern part of The Tableland proper, finally descending by a precipitous brook-valley, where, in chasms of the rock, chunks of ice 30 feet thick still lingered, and returned home. We had tramped, much of the time vertically and on the most slippery of wet magnesian rocks, about 25 miles; and the Peak of Teneriffe is still not botanized. It was a magnificent tramp and dramatically interesting but, botanically, productive of no novelties. Wiegand had got most of the specialties in 1910 and Long and Fogg had seen them on the North Arm of Bay of Islands in 1926; but, selfishly, I was delighted to see them again and, in a paternal way, so to speak (as sponsor of four of them), to reassure myself that they still abound on this great serpentine barren: *Adiantum pedatum* var. *aleuticum*, *Danthonia intermedia*, *Salix anglorum* var. *kophophylla*, *S. cordifolia* var. *Macounii*, *Arenaria marcescens* (PLATE 255) and *cylindrocarpa* (PLATE 256), *Cerastium terrae-novae* (PLATE 257) and always puzzling plants of the *C. arvense* affinity, *Lychnis alpina* L., *Conioselinum pumilum*, *Statice labradorica* and *Solidago hispida* var. *tonsa* Fern. On the lower barrens,

where it was moist and peaty, the handsome *Carex Wiegandii* Mackenz. abounds, the northernmost station yet known; and with it grows fairly typical *Pyrola rotundifolia* L., also at a northern limit. Thickets along Winterhouse Brook are our northernmost station for the New York Fern, *Thelypteris noveboracensis* (L.) Nieuwl. and for several other but inconspicuous species (in *Carex*, *Juncus*, etc.). The *Juncus alpinus* of these lower barrens was nearer the typical plant of Europe than much of the American material. But I get little satisfaction from trying to follow the recent segregations proposed in Europe (see Part III); the Newfoundland plants vary from simple individuals with 1 or 2 glomerules to others with 25 or more. These variations are very obviously responses to minor conditions of habitat. It seems sufficient to treat the Newfoundland plants as typical *J. alpinus*, with flowers all sessile or uniformly short-pedicelled; and var. *rariflorus* Hartm. (1849) (var. *insignis* Fries (1890), *J. nodulosus* Wahlenb. (1820)). Var. *alpestris* Hartm. and *J. nodulosus* β. *biceps et uniceps* Laestad., sometimes maintained, seem to be merely dwarf or poorly developed states. At one point *Carex Buxbaumii* had very pale (almost whitish) instead of dark scales, f. *dilutior* Kükenth., which we had never met.

We spent two days on Lookout Mountain, the first collecting on the slope and making a start on its broad tableland (the uplifted Cretaceous Peneplane), at about 1800 feet altitude. The second day we crossed the tableland and the most strenuous member of the party (B. L.) went to one of the Lookouts, bare castellated and ragged crags of rotted diorite (alt. about 2500 feet) at the western edge of the plateau. The second day was sultry, and so hot that the younger members of the party stripped to their BVD's; and, instead of enjoying the cool and bracing air of a theoretical mountain-top, we boiled and simmered all day. By afternoon, at each step we were saying, "What's the use?"; still we plodded hopefully on across the peaty barren. When we got back to Woody Point in the evening we found everyone panting, with the mercury at 100° Farenheit! Such midsummer days are not uncommon on the tablelands of Newfoundland.

Experiences on the tableland of Blomidon in 1910, on that of Lark Mt. in 1926, and others recorded earlier in this journal should have taught us; nevertheless, we went from the sea-level rocks and taluses of Bonne Bay, with their subarctic and even high-arctic species,

to the tableland of Lookout Mountain actually expecting to find an alpine flora! Instead, the great plateau is like that of Blomidon or of the Topsail region, a prairie-like expanse of peat, with innumerable shallow depressions and small pools. In the pools one finds occasional colonies of the boreal *Sparganium hyperboreum*, but much more often the Coastal Plain *Utricularia geminiscapa* Benj. (*U. clandestina*) (MAP 6) and the New Jersey Pine Barren *Potamogeton confervoides* and *P. Oakesianus*. *Pogonia ophioglossoides*, *Calopogon pulchellus* and *Habenaria clavellata* are there, and the crimson-flowered *H. psycodes* is positively dominant. *Rynchospora fusca* and *alba*, *Carex exilis* and *livida* (var. *Grayana*) and *Juncus pelocarpus* abound. Kneeling by



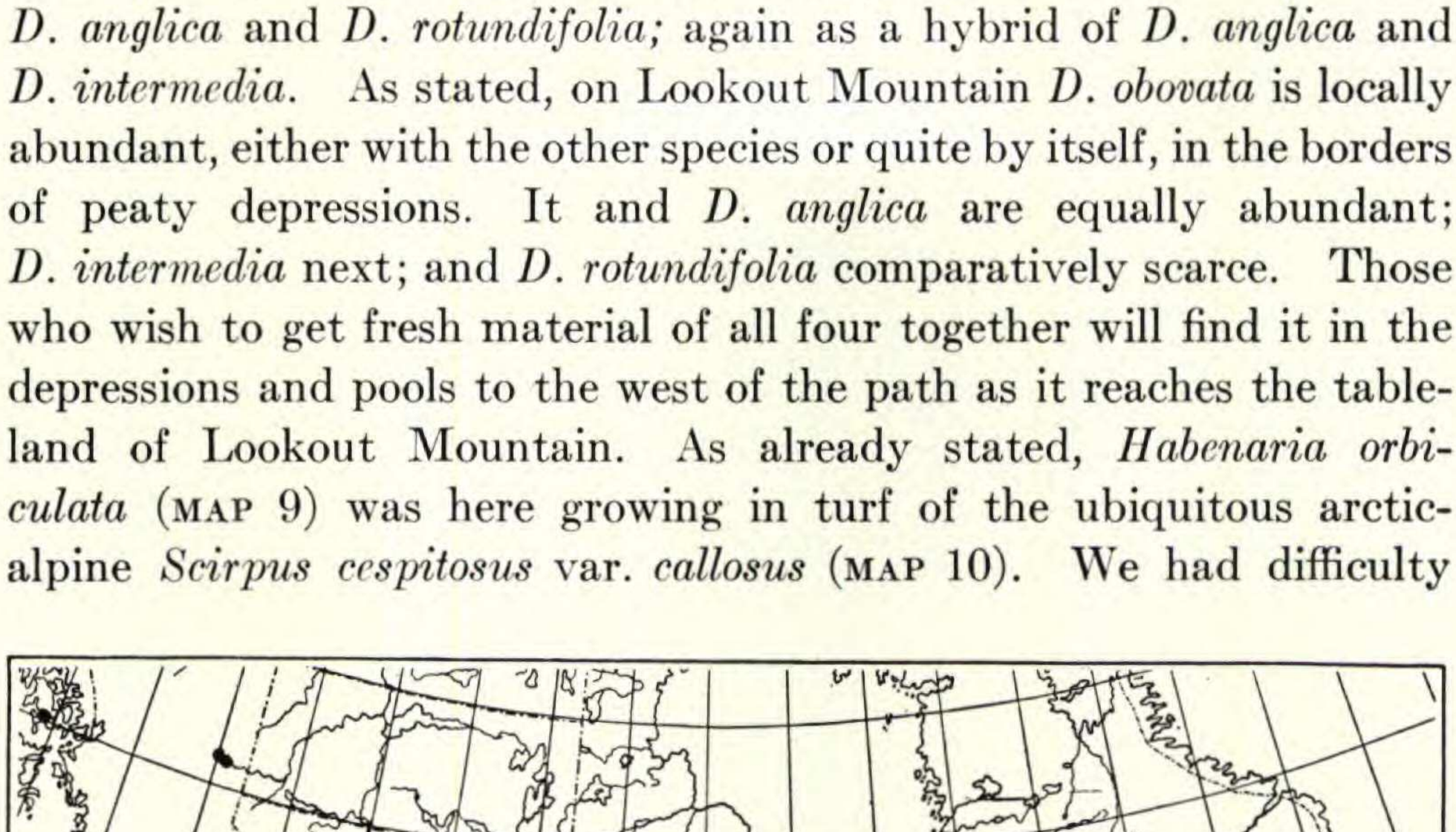
Map 6. Range of UTRICULARIA GEMINISCAPA.

the peaty pools one finds himself in the inevitable *Schizaea pusilla* (MAP 7) of the Pine Barrens, and *Bartonia*, and very often *Muhlenbergia uniflora* (var. *terrae-novae*); and in a rock-bottomed tarn nearly over to the Lookouts *Lobelia Dortmanna* (MAP 8) flourishes. The only notable plants, where we spent the most time (on both days) studying these peaty barrens, which do not occur in southern New Jersey are the *Sparganium* (*hyperboreum*), the tiny yellow-fruited *Eleocharis nitida* Fern. (which formed such dense carpets that I was inclined to jeer Long for having overlooked it in the Pine Barrens), and *Drosera anglica*. About many pools, either with *D. anglica*, *D. rotundifolia* and *D. intermedia* Hayne (*D. longifolia* L. in part, a name too confused in its application) or in extensive colonies by it-

Map 7. Range of SCHIZAEA PUSILLA.

Map 8. American Range of LOBELIA DORTMANNA.

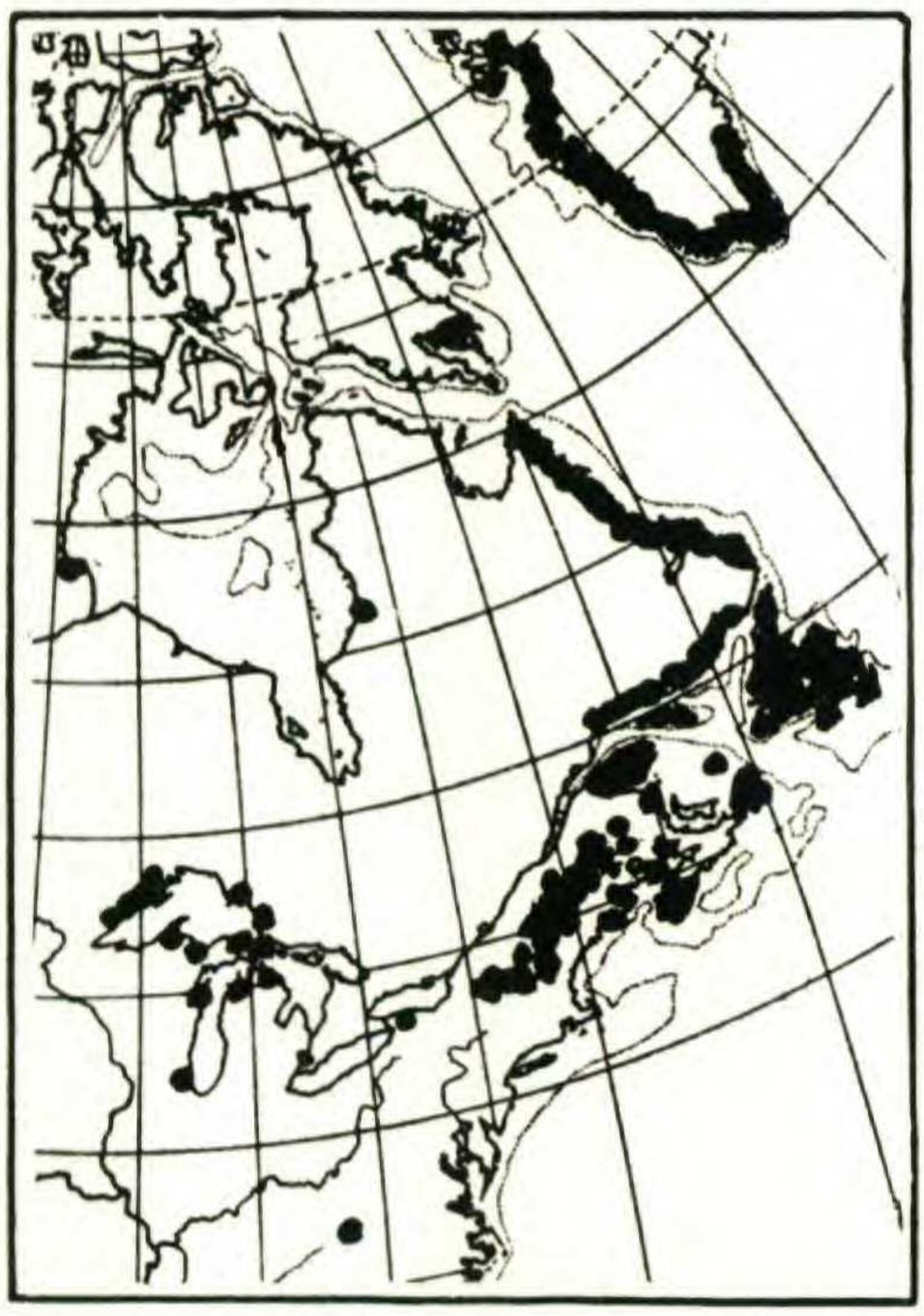
self, was another *Drosera*, quite strange to us. This proved to be the European *D. obovata* Mert. & Koch., new to North America. In Europe it is sometimes treated as a species; sometimes as a variety of *D. anglica* (*D. anglica β. obovata* Planch.); sometimes as a hybrid of *D. anglica* and *D. rotundifolia;* again as a hybrid of *D. anglica* and *D. intermedia.* As stated, on Lookout Mountain *D. obovata* is locally abundant, either with the other species or quite by itself, in the borders of peaty depressions. It and *D. anglica* are equally abundant; *D. intermedia* next; and *D. rotundifolia* comparatively scarce. Those who wish to get fresh material of all four together will find it in the depressions and pools to the west of the path as it reaches the table-land of Lookout Mountain. As already stated, *Habenaria orbiculata* (MAP 9) was here growing in turf of the ubiquitous arctic-alpine *Scirpus cespitosus* var. *callosus* (MAP 10). We had difficulty



Map 9. Range of HABENARIA ORBICULATA.

in believing our own eyes and, at my request, Fogg made detailed drawings of its flowers, lest we might forget how the fresh flowers appeared; but we cannot make it anything but *H. orbiculata* of "rich woods" on the continent.

By the time we had got well up on the bases of the dry diorite peaks (the Lookouts), Fogg and I were content to linger over banks of the charming little chocolate-flowered *Euphrasia Williamsii* var. *vestita* and to let Long tackle single-handed the ragged and bleak crest. His only trophy was a mass of over-ripe *Antennaria cana* (Fern. & Wieg.) Fern., one of the most attractive of the genus, this station the first south of Pointe Riche.



Map 10. Eastern American Range of SCIRPUS CESPITOSUS, var. CALLOSUS.

We, of course, wanted to get on Gros Morne, Gallie's Head, Killdevil, the Peak of Teneriffe, and other mountains of which we did not learn the names. We were, however, drawn in so many directions and were so controlled by the frequent fogs that Killdevil was the only other mountain touched. The vividness of the descriptive name reflects the reputation of its steep slope among people who have always lived and hunted among precipitous hills; and in the ascent and descent Mr. Preble, although retired for several years, showed the result of long training and greatly outstripped the boys. We had other reasons for lagging besides shortness of breath. Killdevil, where the steep path has been worn, is composed of very silicious rock; and high on its slope we found the southern *Cypripedium acaule*, at the only station we saw around Bonne Bay. We were also interested in comparing the flavors of different blueberries! At one point on a rock-slide of the quartzite a few plants of *Solidago calcicola* frankly belied its name, though we suspect that it is a waif blown in from some more favorable habitat near-by. *Woodsia ilvensis*, which we had not seen lower down, was unusually large on the

quartzite cliffs; and when we reached the comparatively narrow table-land we found a very perfect demonstration of the three crowberries of Newfoundland: *Empetrum nigrum*, *E. nigrum* forma *purpureum* (Raf.) Fern., with plum-purple fruits (new to Newfoundland) and *E. Eamesii*. The summit-ridge was as disappointing as the dry slopes, with only enough *Phyllodoce caerulea* and *Carex stylosa* to keep it from being utterly hopeless. Plodding doggedly on to the west, we were suddenly conscious of an abrupt change: the regular western Newfoundland Saxifages and Drabas, *Carex rupestris*, *Solidago multiradiata*, *Tofieldia minima* and other old friends. The extreme westerly crest of Killdevil was limestone, just as if some of the limestone at sea-level, with its distinctive flora, had been torn out by the uplift of the quartzite block and carried up to 2100 feet; and, just as fate has decreed in so many cases, we reached the interesting botanizing when it was time to start back, if we were to make the shore safely before dark. But we had to investigate a little: *Woodsia alpina* here mingled with *W. ilvensis; Botrychium matricariaefolium*, *Arabis Drummondi*, *Habenaria viridis* var. *bracteata* and *Antennaria neodioica* var. *attenuata* gave a singularly southern aspect, rather than alpine; but a thicket of *Salix cordifolia* var. *callicarpaea* (Trautv.) Fern., the tallest we have ever seen (sheltered in crevices in the limestone) was decidedly more boreal; and *Potentilla norvegica* var. *labradorica* (Lehm.) Fern. and *Galium kamtschaticum*, in its shade, and *Epilobium lactiflorum* Hausskn. in the thickets of *Salix vestita*, were also boreal. Another *Antennaria* (undescribed, PLATE 266), with the largest brown heads of any in Newfoundland, made a fine carpet, strongly contrasting with the pale-headed species with which it grew. It was getting so close to twilight that we were ticklish about climbing around the rotted limestone; but Fogg volunteered to cross over to a more western crag, though he promptly returned, driven out by millions of mosquitoes which were beginning to assemble for the evening. He had *Oxytropis johannensis* Fern.[1]; and from the crest he had reached a high escarpment of limestone evidently extended for thousands of feet toward the Bay—unworked and awaiting a party with plenty of daylight. A similar high escarpment seems to occur at the westerly crest of Gallie's Head; and, through the woods to the east of Killdevil, we could see others; there is plenty

[1] RHODORA, XXX. 145, t. 173 (1928).

to do, and we should not mind if the Appalachian Mountain Club discovered the region and cut some good trails.

Mr. Preble was anxious for us to see the deadwaters of Main River, which enters Main Arm, for "every kind of flower" grows there. So, one day, August 19th, we landed on the alluvial flats, planning to follow up river four miles to his flower-garden. The flats where we landed proved too fascinating and by night we had scarcely got out of sight of the moored boat. Another trip on the 27th, after Fogg had been obliged to return home, pleased Mr. Preble no better: we grubbed about in the tidal flats and got nowhere near the real area of wild flowers which he was intent on showing us. It was too much to expect him to appreciate all the range-extensions we were noting. *Typha latifolia* formed a dense (though sterile) stand at the border of a bog, where *Scheuchzeria palustris* var. *americana* Fern. reaches a northern limit and where the yellow-green *Sarracenia purpurea* forma *heterophylla* (Eaton) Fern. abounds. The *Typha*, Mr. Preble told us, is really abundant some miles farther north, along Baker Brook, where the fish-packers go to get their "flag." In the woods and thickets *Fraxinus nigra* and *Corylus cornuta* Marsh. (*C. rostrata*) were reaching northern outposts; and the abundant *Arceuthobium pusillum*, parasitic on *Picea mariana*, was also an extension northward. Various *Carices* were also absorbing our attention, very complex series in the *flava*- and the *stellulata*-groups. In wet swales *Myosotis laxa* and *M. scorpioides* both abounded; and one alluvial woodland had a great abundance of *Trillium cernuum*, another northern extension. To a New Englander these were, of course, a very tame lot of species; but they were significant as showing the very temperate conditions in sheltered river-estuaries, as contrasted with the arctic quality of the typical shore-vegetation on the outer coast.

The halophytes particularly absorbed us. The brackish mud-flats were carpeted with *Eleocharis parvula* (R. & S.) Link (*Scirpus nanus*), at a new northern limit; and mixed with it, and at first almost indistinguishable from it, was *E. acicularis* var. *submersa* (Hj. Nilss.) Svenson[1] of Greenland, Arctic America and Labrador, new to Newfoundland. *Carex hormathodes* abounded in the brackish shores, an extension north from Bay St. George, and with it *Juncus Gerardi*, also a northern extension. At one point there was an extensive development of *Scirpus americanus* (all sterile at this northeastern

[1] Svenson, Rhodora, xxxi. 188 (1929).

outpost); and the southern and chiefly maritime *Juncus articulatus* var. *obtusatus*, new to Newfoundland, abounded. The shallow films of salt water were filled with *Zannichellia palustris* var. *major* (Boenn.) Koch and a jumble of variations of *Ruppia maritima*,[1] the latter all growing together and clearly not individual responses to different depths and temperatures of the water: var. *obliqua* (Schur) Aschers. & Graebn., a European variety which we now know very generally about the Gulf of St. Lawrence (western Newfoundland, Miquelon, Anticosti, the lower St. Lawrence, Magdalen Islands, Prince Edward Island and Cape Breton); var. *intermedia* (Thedenius) Aschers. & Graebn., more local in eastern America (our station at the mouth of Main River and salt marshes of Rimouski Co., Quebec); and var. *brevirostris* Agardh, another variety (in Europe often treated as a species) known in America only about the Gulf of St. Lawrence (our new station, the first in Newfoundland, the "Côte Nord" of Quebec, and the Mingan Islands and the Magdalen Islands).

These and numerous other halophytes held our attention through much of our two days at the mouth of Main River; but above the saline area the broad gravelly or alluvial flats will be quite as productive. When we were there they were a splendid show of the exquisite creamy-white flowers of *Parnassia caroliniana*, the blue-purple and white of the delicate racemes of *Lobelia Kalmii*, and bright red of the fruiting racemes of *Tofieldia glutinosa*. *Juncus Dudleyi*, purplish-bronze in maturity, was a good find, in Newfoundland previously known only from the Bay of Islands; and these alluvial islands seemed to be the center of distribution of the usually rare *Carex Hostiana* var. *laurentiana* Fern. & Wieg.[2] It formed fine tussocks over a large area and with it were several tussocks of what was apparently a hybrid of it with *C. flava*. Near by, *C. flava* was also crossing with *C. Oederi* var. *pumila*. *Solidago lepida* var. *elongata* (Nutt.) Fern.,[3] the first east of Gaspé, was in the borders of thickets; and the flats were often covered with willows like those of northern Maine and northern New Brunswick: *Salix lucida* and its var. *intonsa*, *S. cordata*, *S. pellita* and *S. glaucophylloides* Fern.

We did not come within two miles of the area Mr. Preble was anxious for us to see, where "every kind of flower" grows. That,

[1] For revision of the North American varieties of *Ruppia maritima* see Fernald & Wiegand, Rhodora, xvi. 119–127, t. 110 (1914).

[2] Rhodora, xxvi. 122 (1924).

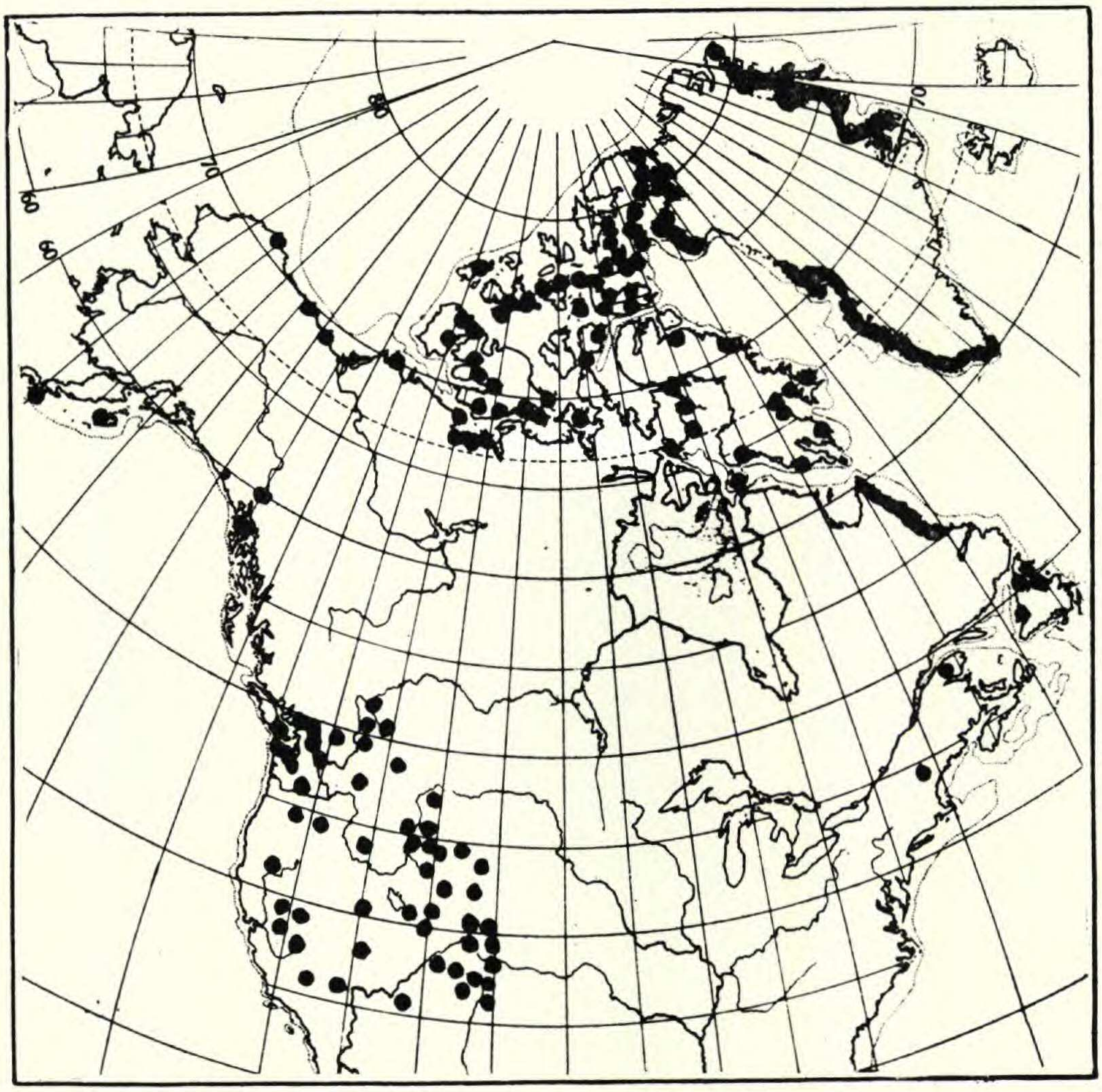
[3] Rhodora, xvii. 9 (1915).

along with many other alluring spots, must wait. A trip up Deer Brook brought a few more northward extensions of range; and another, to the mouths of Middle Brook and of McKenzie River, yielded more colonies of the estuary species, as well as *Plantago major* var. *asiatica*, new to Newfoundland. In the shallow bay at this point Eel Grass, *Zostera marina*, was very freely fruiting, the leaves of the fruiting branches much smaller than on the foliage-branches. All the material in Newfoundland and south along the Atlantic coast seems to belong to *Z. marina* var. *stenophylla* Aschers. & Graeber. Its leaves vary greatly in breadth, from 1.5–6 mm. wide (in dried plants); but they are all coriaceous and opaque, with only 3 (very rarely 5) strong nerves. Var. *stenophylla* occurs northward to southeastern Labrador, locally in southwestern Greenland, in James Bay, in the North Pacific and in northern Eurasian waters. Typical *Z. marina* seems to be the coarser plant of western European (and Mediterranean) waters, with thinner and subtransparent leaves up to 12 mm. wide, mostly with 5–7 strong nerves besides the more numerous finer ones. This larger extreme (typical *Z. marina*) has its counterpart on the Pacific coast of North America, whence it was published as *Z. marina* var. *latifolia* by Morong and as a species, *Z. pacifica*, by Watson. Whether there are good fruit-characters to separate the plants I am at present unable to say, for want of sufficient fruit of the broad-leaved plants of western Europe and of western North America. Should it eventually prove that *Z. marina* var. *stenophylla* Aschers. & Graebn. (1897) is a distinct species, it must be called, by a quite unintentional coincidence, *Z. stenophylla* Raf. Am. Mo. Mag. ii. 175 (1818).

We had originally had Trout River in our schedule; and one day, August 14th, starting from Woody Point for the region of Lomond (near the mouth of Main River), we suddenly perceived that it was absolutely calm outside. There was nothing to do, then, but make a trip southward along the outer wall and to go, while going was good, as far as possible southward along the coast. Passing under Western Head, at the southern entrance to Bonne Bay, we were attracted to the steeple-like pinnacles of diorite which stand like scattered spires (PLATE 237)[1] over the slope—mute evidence that no recent continental ice-sheet has passed over the area, with the inevitable denudation and removal of slender pinnacles. Landing under the nearest, where

[1] This half of plate 237, made from a photograph taken from a throbbing motor boat, is, necessarily, a bit vague. It, however, shows the important physiographic feature.

loose talus poured down the steep slope, we were at once, close to sea-level, in the mixture of Canadian, Hudsonian and Arctic-alpine vegetation already emphasized. Other landings, at the outer base of Western Head and, farther south, on the basalts and the shales near Wallace's Brook, showed the same conditions. Most of the arctic species had been repeatedly collected and, consequently,



Map 11. American Range of OXYRIA DIGYNA.

need be merely suggested (*Carex scirpoidea, Juncus trifidus, Silene acaulis* var. *exscapa, Saxifraga oppositifolia,* etc.); but it was certainly a surprise to find *Oxyria digyna* (MAP 11) abundant at sea-level, a species ranging south from "farthest north" (lat. 83° in Greenland and Ellesmereland), and in Gaspé and New England known only in the most alpine areas. *Luzula campestris* var. *alpina* Gaud., perhaps

better treated as a species, *L. sudetica* (Willd.) DC., was a good addition to the Newfoundland flora; and much of the *Silene acaulis* var. *exscapa* had elongate peduncles (the ordinary plant with flowers subsessile or buried in the leafy tufts). We had great hopes of this plant and collected much material in fruit. It was past flowering and when in anthesis it may prove to be of great interest. For the present we are calling it *S. acaulis* var. *exscapa*, forma *caulescens* (Vaccari) Fiori, a plant not previously recorded in America. On some of the slopes *Hedysarum alpinum*, with lingering flowers, was in fine fruit, as great a display of this elegant plant as we had ever met. *Agropyron* here, as everywhere in Newfoundland, was so perplexing that we collected much material, toward a restudy of the group; and we have a fine series of an *Oenothera* of the *biennis*-group at about its northern limit. One small pocket of *Gentiana nesophila* was all we could find, and there was not a sign of the ordinarily ubiquitous *G. Amarella* and *Halenia deflexa;* and *Euphrasia* was disconcertingly restricted in quantity.

Finally, after Fogg was obliged to leave and Long and I had made the last trips about Bonne Bay, we two sailed for Bay of Islands to connect with the Clarke boat which would sail early in September for Quebec and Montreal. Bonne Bay, which we had originally passed by in our schedule as "all worked out," had proved to be a mine of new discoveries; and we hadn't been on Gros Morne, Gallie's Head, the Peak of Teneriffe, nor the fascinating tablelands to the north, nor the spectacular mountains slightly to the south, about Trout River. Farther south, Chimney Cove, where the invalid Waghorne got choice things, was again unvisited; and we did not see the deadwaters of Main River where grow "every kind of flower." Mr. Preble tried to lure us back the next summer but, unfortunately, although his quite unnecessary bait was most tempting, further expeditions have thus far been out of the question.

Waiting for the steamer to load at Corner Brook, Long and I revisited Hannah's Head and the woodlands along the Humber, where, at the opening of the summer, we had had such "thrills." At the first of September Hannah's Head was excessively dry and no one would guess that beneath the parched crust there were tens of thousands of fine buds of *Botrychium Lunaria.* The autumn plants were on; and *Solidago canadensis*, which seems to be a very rare plant in Newfoundland, was conspicuous. *Lycopodium tristachyum*,

another species rare in Newfoundland, grew in the dry woods and well up on the open rocky slope. At our old station *Orobanche terrae-novae* was ripe, its capsules slenderly lanceolate, as contrasted with the ovoid-conic capsules of *O. uniflora* of the continent.

Early in the summer, while waiting for the "Sagona," Mr. and Mrs. Morris had discovered a turfy slope near Petrie's where most of the *Botrychia* of Newfoundland congregate, and, best of all, they had *Botrychium angustisegmentum* (Pease & Moore) Fern.,[1] a Canadio-Alleghenian species new to Newfoundland. Sunday, September 1, was very rainy, but, determined to get specimens of the latter species, we went in rain-coats and with umbrellas (for we were now packed up and in "store clothes") to the area—*B. simplex, angustisegmentum, matricariaefolium*, in several forms, and *multifidum* (Gmel.) Rupr. (*B. ternatum* var. *rutaefolium*). Not far away were *B. Lunaria* and *B. virginianum* var. *europaeum* Ångström; so that Humber Arm lacks only true *B. lanceolatum* to complete the list of known Newfoundland species.

Part II. Phytogeographic Considerations

When we left Newfoundland we had done nothing we had expected to do and had done many things we had originally planned not to do, discounted at the start as not at all worth while. Nevertheless, we were wholly gratified with the results and our collection of discriminatingly selected specialties (with most of the commonest species uncollected) amounted to nearly 7000 sheets. We had learned anew one humiliating truth: that the best-worked areas, even after weeks of exploration, still need careful study; and we had been especially impressed by three points of large phytogeographic bearing.

The least significant of the three was the complete absence in the summer of 1929 of several annual or biennial species which, in 1924 and 1925, had been everywhere abundant in appropriate habitats. In those years the open limy shores and the barrens near sea-level in northwestern Newfoundland had been brilliant with the biennial *Gentiana nesophila* Holm and *propinqua* Richardson, and the superabundant *G. Amarella*. It was then impossible to avoid stepping upon biennial *Halenia deflexa;* while annual *Euphrasia* in multitudes, both of colonies and of species, colored all turfy slopes. But in 1929 we saw not a solitary individual of *Halenia deflexa* nor of *Gentiana*

[1] Rhodora, xvii. 87 (1915).

Amarella nor *G. propinqua*. The complete absence of these plants was vividly brought home, since I had confidently promised to secure seeds of all variations of *Halenia* for Dr. Caroline Allen, who was monographing the genus. Our failure to find these usually ubiquitous biennials of the region, was, therefore, not due to two of them being on the "taboo-list." *Euphrasia*, too, was a disappointment. The alpine *E. Williamsii* prospered, but the lowland species were very meagrely represented; in fact, *E. purpurea* Reeks, var. *Farlowii* (Robinson) Fern. & Wieg., formerly one of the commonest maritime species of the West Coast, was nowhere seen, nor was *E. stricta* Host, which in the past has been abundant about outer Bonne Bay and St. John Bay; while the usually abundant *E. arctica* Lange, of the upper borders of the strand, was found as only a single small colony. Our station for the biennial *Androsace septentrionalis* on the slope of Tucker's Head yielded exactly two diminutive individuals (we took pains to scatter some seed!). On the cliff at Rivière à la Martre on the Gaspé Coast it can be secured in quantity, as also on the Mingan Islands; in other words, the species usually occurs in abundance.

This fact, that most of the annual and biennial species of the sea-level habitats in northwestern Newfoundland had nearly or quite vanished from the flora in 1929, was very impressive. Certainly we had not diminished them in 1924 and 1925, for neither we nor any other botanists had ever visited any of these special areas, except La Pylaie in 1820, when he recorded and collected not a single *Euphrasia* nor *Gentiana propinqua* nor *Androsace*, and Wiegand in 1910, who did not visit the identical spots. In writing of our visit to Lark Harbor in 1926 (p. 4) I pointed out that there had been no summer, that early in September the snow of the preceding winter remained unthawed in many places. Similarly, we were told, 1927 and 1928 were "summerless" years; 1929, with bright sunshine and some piping hot days, was heralded as the first real summer for four years. We were, apparently, witnessing one of the tragedies of boreal floras. With three successive years when the late-flowering annuals and biennials had been unable to mature seeds, these species had become, at least temporarily, almost extinct; while at least six of them seemed completely to have disappeared. Some of them (*Gentiana nesophila*, *Androsace septentrionalis* and some of the Euphrasias) had barely survived; and one of the most interesting observations to be made on

the next trip to the West Coast is going to be whether or not any or all of these handicapped species have "come back." It requires no great powers of imagination to see why in the Arctic flora annuals are essentially wanting!

The second point of phytogeographic importance concerns the antiquity of the Coastal Plain flora, characterizing the highest "alpine" and treeless tablelands, which form the peaty summit-levels of western Newfoundland, but occurring quite as abundantly on the lowland bog-barrens of southern and central Newfoundland. In discussing, in 1911, this austral or Coastal Plain element in the Newfoundland flora, accepting the then current interpretation of Pleistocene glaciation, I concluded that the Coastal Plain element in the flora and the fauna had reached Newfoundland in post-Wisconsin time from the South, by migration along the then elevated but now submerged Continental Shelf (the northern extension of the true Coastal Plain of the South). Subsequently this interpretation gained additional support by the discovery in Nova Scotia of more than 100 additional Coastal Plain species.

Fortunately, since 1911 the problem of changes along our coast has received some of the attention it deserves and which is certainly needed, if we are correctly to interpret the migrations of plants and animals between Newfoundland and New Jersey. In 1915 the brilliant investigator, the late Professor Joseph Barrell, in a study of *Factors in Movements of the Strand Line and their Results in the Pleistocene and Post-Pleistocene*,[1] enumerated various isostatic factors which must be considered, but the strongest challenge to my interpretation of 1911, that the migration was post-Wisconsin, is contained in the remarkably detailed study of *The New England-Acadian Shoreline* by Professor Douglas Johnson. Johnson's mature conclusions bear so strongly on the problem of migration of the so-called Coastal Plain element in the flora of Newfoundland that I venture to reprint:

Age of Banks Cuesta and Date of Submergence.—The interpretation of the Banks as a coastal plain cuesta receives support from the fact that in the course of their operations on the Banks fishermen bring to the surface fragments of fossiliferous sandstone and limestone. A series of these collected and described by Upham, and determined by Verrill to be of Tertiary age (probably Miocene or even Pliocene), shows that the submergence must have occurred at the end of the Tertiary or still later in post-Tertiary time; for after the deposition of the late Tertiary sedi-

[1] Barrell, Am. Journ. Sci. ser. 4, xl. 1–22 (1915).

ments we must allow time for the erosion of the lowland prior to its submergence. If the bevelled top of the cuesta is the remnant of a peneplane developed on the coastal plain beds (and perhaps also on the crystallines of the oldland), then since the deposition of the late Tertiary formations the land was uplifted, one cycle of erosion completed, another uplift occurred, and in the new cycle maturity was attained before subsidence drowned the resultant topography. Thus we should expect the subsidence to be at least post-Miocene, and more probably post-Pliocene. It should be observed that if the Banks Cuesta is composed in large part of late Tertiary deposits, it is not geologically the equivalent of the principal cuesta farther west. It is, however, quite normal for an inner lowland to be bordered by a cuesta of resistant Tertiary beds in one place, and by a cuesta of resistant Cretaceous beds elsewhere, if the cuesta maker of one locality decreases in resistance at another, or is cut out by an unconformity or otherwise, in such manner as to give at most only a minor cuesta on the inface or backslope of the new major cuesta which replaces the first, due to increased resistance of higher or lower beds in the coastal plain series.

Relation of Banks Cuesta to Former Plant Migrations.—The conclusions here reached are not without interest in connection with an important problem of plant geography. Fernald, developing and extending a conception first stated by Hollick, has shown that many species of plants characteristic of the Pine Barren and Coastal Plain floras of New Jersey and the south occur at various points along the New England and Acadian coasts, and even on Newfoundland. After examining the means by which this coastal plain flora (believed to be incapable of migrating over the oldland which now reaches clear to the sea in New England and the lands northeast) could have reached the far northern localities, he reached the conclusion that the submerged Banks off these coasts must recently have projected far enough above sealevel to give a sandy land-bridge along which the flora could spread freely. Following Daly he appealed to a lowering of sealevel during the glacial epoch to lay bare the crests of the Banks. Barrell pointed out that this would require the migration of the flora during a cold period, whereas the evidence indicates, and Fernald agrees, that such migration must have taken place when the climate was as warm as, or warmer than, that of the present; and he suggested a bulging up of the Banks zone marginal to the ice sheet while the mainland was weighed down by the ice, followed by further uplift as the ice melted and the mainland rose, with a later settling back or subsidence of the Banks as an after-effect of deglaciation.

The submarine physiography of the Gulf of Maine offers striking confirmation of the hypothesis that the Banks were formerly much higher; but it throws no clear light on Barrell's theory of an up-bulging during the glacial period. The inner lowland and cuesta represent a great work of erosion which must have been practically completed before the ice invasion. There seems to be no reason, however, for placing the plant migration so late as post-glacial time. Fernald recognizes the possibility that the plants "migrated northward on the continental shelf prior to the Wisconsin glaciation, and persisted outside the subsequently glaciated area, finally taking possession of their present isolated habitats on the receding of the ice"; and he finds evidence of the existence of "some tract along the coast, especially of Acadia and Newfoundland, which

held this flora . . . continuously through the Pleistocene." In another connection he definitely places the date of migration as "late Tertiary"; and in a letter to the author dated September 28, 1923, he writes: "In regard to the possibility of the Coastal Plain flora migrating to Nova Scotia and Newfoundland in pre-glacial times, there is absolutely no botanical reason, so far as I can see, why this might not have been the case. In fact, there are certain rather striking points which would indicate that a migration in late Tertiary or early Pleistocene times took place." Some of the points referred to in the last quotation are considered in Fernald's later contributions to the subject, published in 1918 and 1921; and his reference in the last paper to an elevation of the continental shelf "since the Pleistocene glaciation" must be read in the light of his other clear statements that the plant migration in question probably antedated the glacial period.

Whatever the later history of the region, the submarine physiography demonstrates the presence of a normal, maturely dissected coastal plain bordering the New England-Acadian oldland at a period which would account for the very early migration of the Pine Barrens flora contemplated in the foregoing quotations. There were then no such broad channels of open water as must have separated certain of the Banks on the theory of a more limited lowering of sealevel due to glaciation; while instead of a temporary land bridge due to bulging at the margin of the glacier there was a long-enduring coastal plain topography extending continuously from New Jersey and southward to beyond Newfoundland. Thus the botanical problen of migration would seem to be measurably independent of changes of sealevel due to glaciation and of marginal bulging due to crustal readjustment under the weight of the ice; although we recognize the possibility that both these factors may have played a rôle in the later history of the Banks Cuesta.[1]

Still other lines of investigation were demonstrating that this migration need not have been a recent one. Dissatisfied with the then current idea, that Newfoundland had been completely denuded by the later Pleistocene glaciations which would have wiped out its flora and fauna, I appealed in 1923 to the venerable and unchallenged student of the Pleistocene, Professor A. P. Coleman, who had already emphasized the lack of glaciation (consequently the antiquity of the relic and endemic flora and fauna) of the alpine area of the Shickshock Mts. in Gaspé. To me the Newfoundland situation seemed identical: conspicuous and unquestioned denudation of the hills in some areas (Burgeo, for instance, PLATE 233); but in others, notably the West Coast and the Long Range, a lack of wholesale denudation by an ice-sheet. In 1926 Professor Coleman published his results, from which I quote pertinent passages (with apologies for such as modesty might require my omitting, except that they demonstrate the importance of phytogeography in the geological problem):

[1] Douglas Johnson, The New England-Acadian Shoreline, 301–304 (1925). N. Y. John Wiley & Sons; London, Chapman & Hall.

All the available geological literature on the subject has been consulted . . . ; but it is interesting to note that the most important work is by an eminent botanist, ... , who, with various assistants, has studied the plants of many parts of the island and has discovered a large number of peculiar, often endemic, species which have survived the ice age. . . . . His latest paper, on the "Persistence of Plants in Unglaciated Areas of Boreal America," . . . must be taken into account by students of the Pleistocene.

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In most parts of the [Avalon] peninsula the sheet of drift is thin and does not indicate powerful ice action. It seems that the last ice was not heavy enough to depress the region by its weight, since no raised beaches have been reported around the Avalon peninsula. It was thought by Daly at one time that Signal Hill at St. Johns was submerged, but a later study of the hill convinced him that there was no change of level; and this agrees with my own observations on the coast near St. Johns, which failed to show any terraces.

The facts observed seem best accounted for by supposing an early Pleistocene ice cap covering the whole peninsula, followed by a long period of weathering, and then by small local ice sheets of Wisconsin age, which did not unite to form a complete ice cap. If the earlier and heavier ice mass depressed the region seriously any marine terraces formed during the interglacial time seem to have been obscured or destroyed; and the small local ice sheets of the Wisconsin were not sufficient to cause depression.

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[About Notre Dame Bay] The general impression was that the glaciation was ancient except along the shore of the bay at Lewisporte, where the bowlder clay was soft and fresh looking, with plenty of well-preserved striated stones. It may be that a valley glacier of Wisconsin times moved northward through the bay.

Bishop's Falls and Grand Falls, 20 or 30 miles west of Notre Dame Junction, show hard and ancient-looking bowlder clay, of deep brown color, in which striated bowlders are not infrequent. Exposed ridges of sandstone rise above the till, sometimes as jagged edges which have been deeply eaten by weathering.

To the north of Bishop's Falls great kame deposits indicate a prolonged halt of the ice sheet, and near the harbor of Botwood there are rolling hills of gravel and a few shallow kettles. At the shore of the bay the only evidence of ice action consists of a few bowlders scattered over hills of rhyolite penetrating slaty sandstone of a reddish color. Apparently little work was done by the ice beyond the morainic deposits.

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The Topsails, about 35 miles farther west, are interesting as hills rising above the highest tableland crossed by the railway, which reaches 1,550 feet a few miles east of Gafftopsail Station. The general character of the tableland does not suggest glaciation, since it is a plain covered with great bowlders of granite and gneiss, just like the underlying bed rock which shows as low bare ridges in places but is usually hidden by coarse and fine granitic débris which seems to have originated in place.

A few striated stones were observed near Gafftopsail Station, but no bowlder clay, only sandy and gritty material. At one place along the railway east of the Station a surface of porphyrite is apparently faintly striated in a north-and-south direction. Gafftopsail Mountain, reaching over 1,700 feet, consists of granite, and a few rounded bowlders of greenstone are scattered over it, showing that it was crossed by ice, though the rough and weathered surface does not suggest glaciation.

The highest point, a few miles northeast, is Maintopsail (1,829 feet). It also consists of coarse, greatly weathered granite, on which rest a few greenstone pebbles and bowlders which must have been transported by ice. There are several small shallow pools on the summit, probably due to differential weathering, with a gritty sand of angular quartz and feldspar on the bottom. The country all around the mountain is strewn with granite bowlders, among which are innumerable pools and ponds of the same kind as on top, sometimes, however, reaching the size of lakes.

The greatly weathered surface of the mountains and of the tableland a few hundred feet beneath suggests that the glaciation was very ancient, probably of Kansan or Jerseyan age; and nothing was seen to indicate a Wisconsin ice sheet.

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The northwestern side of the [Long] range is much more accessible both by rail and by water and was studied at four points. The first visits were made in 1923 at the suggestion of Dr. Fernald, who had found endemic plants on the range, demanding a much greater lapse of time than the 25,000 or 30,000 years since the Wisconsin glaciation. He had also noted that the surface of the tableland was covered with loose blocks of the underlying bed rock and closely resembled the tablelands of Gaspé and of the Torngats of Northeastern Labrador, which had never been glaciated. His photographs decidedly supported this relationship.

Late in August a climb was made on a tolt, an outlier of the range, which had been used as a hydrographic signal station. It was found by aneroid to be 1,050 feet high, about the level of the edge of Table Mountain, which forms the southwestern end of the Long Range near Cape Ray.

No glacial material was observed on the upper part of the tolt, and its summit consists of loose blocks of granite and gneiss of the same kind as the underlying bed rock. There was no evidence that ice had ever crossed the summit, but the deep U-shaped gorge which separates it from the main range appears to have been carved by a valley glacier.

On the last day of August an ascent was made at Tompkins, 9 miles northeast of the tolt. No signs of glaciation were seen above the edge of the escarpment at 970 feet (aneroid), and a walk of 4 or 5 miles inland over the rolling surface of the table land, reaching 1,908 feet (aneroid), showed only angular blocks of Archaean rock of local origin. No foreign bowlders were found, and the conclusion was reached that the southern part of the Long Range had never been glaciated.

Another ascent made in 1925 at about the same point gave similar results. Angular fragments of Archaean rocks, schists, serpentines, etc., were seen everywhere, but no granites or gneisses which might have come from other parts of the range, and no red sandstones or conglomerates such as ice moving from the Gulf of St. Lawrence must have transported from the plains below.

Another point examined was the table mountain near Port a Port, 20 miles west of Stephenville Crossing on the railway, where Dr. Fernald had reported an unglaciated surface of limestone. Bowlder clay was found up to about 500 feet, but above this there was only bare limestone, and the nearly flat surface at about 1,000 feet (aneroid) was covered with loose fragments of the same rock. At first it seemed that the table had never been ice-covered; but the finding of a few scattered greenstones and granites, much rounded and old-looking, proved that there had been glaciation in the early Pleistocene, though it had escaped ice action in the latest or Wisconsin refrigeration.

Blomidon, appropriately called "Blow-Me-Down" by the local inhabitants as noted by Fernald, 35 miles northeast of Port a Port, at the mouth of the Bay of Islands, consists of serpentine and associated basic rocks. Up to about 1,000 feet red clay with granite or gneiss bowlders was found. Above this a few fragments or small bowlders of granite occur on the weathered surface of serpentine or diorite as for as 1,560 feet. From this to the highest point reached (1,700 feet) only fragments of serpentine or other basic eruptives which might be of local origin were seen, and there was no evidence of glaciation.

Work was done at Bonne Bay, also, about 40 miles farther to the northeast, in the region so well described by Twenhofel, who reported striae on the top of the Bonne Bay table mountain (2,336 feet). His account of the mountain [otherwise] makes it a typical example of an unglaciated serpentine tableland, its surface covered with weathered fragments of the underlying bed rock, and one wonders if there has not been some error in mentioning striated surfaces under those conditions.

Two mountains were climbed near Bonne Bay, one southwest of the village, the other the Gros Morne, some miles to the northeast. The first mountain reaches only 1,263 feet (aneroid), and a few bowlders of granite and of conglomerate occur all the way to the top, proving that it was crossed by ice. The glaciation seems very ancient and weathering has destroyed all evidence of ice action except the rounded bowlders mentioned.

The Gros Morne (2,540) is believed by the people of Bonne Bay to be the highest mountain in Newfoundland. Its gently rolling summit is a tableland of quartzite covered with angular slabs of the same material. A few rounded, much-weathered, bowlders of granite were seen almost to the top, suggesting ancient glaciation; but here, as on other parts of the Long Range, the ice sheet must have disappeared long before Wisconsin times.

The Gros Morne is about midway in the Long Range, and no climbs were made farther northeast, though the narrow, somewhat broken tableland as seen from coasting steamers has the same appearance as the part examined.

Fortunately Dr. Fernald, who covered the region from St. John Bay to Cape Bauld on a botanical investigation in the summer of 1925, has a keen eye for terrain and has sent me photographs and a written description of this northern part of the Long Range, which may be used to complete the account of this little-visited part of Newfoundland.

His observations indicate only slight glaciation, if any, and the photographs show the tablelands, and even some of the lower plains, to be

covered with loose and more or less angular blocks, which could not have been left if there had been Wisconsin glaciation.

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In the foregoing paper it has been shown that there is evidence in Newfoundland of early Pleistocene glaciation by ice caps which covered all of the island except the southern part of the Long Range, which seems to have remained as an area free from ice on which preglacial plants could survive. It is probable that the Newfoundland ice was really the margin of the Labrador sheet which more or less completely filled the Gulf of St. Lawrence and expanded over all but the highest tableland of the southern part of the island. The retreat of the early ice sheet, which was probably of Kansan or Jerseyan age, was followed by great emergence of the land, especially toward the north.

The effects of the early glaciation have been greatly obscured by later processes, and the ancient glaciated surface is in most places covered with débris and fragments of the underlying rock resulting from long-continued weathering. As a rule the only evidence of the early ice sheets is to be found in rounded erratics of foreign origin lingering unconsumed among the blocks of local origin. Probably hundreds of thousands of years elapsed after the early glaciation before the still fresh bowlder clay and striated surfaces were formed by the less extensive Wisconsin ice sheets.

In one place, at Curling on the Bay of Islands, interglacial materials containing marine shells have been found between two bowlder clays; but elsewhere the time interval is shown only by the profound weathering undergone by the older materials.

The Wisconsin ice probably covered less than half the island and was in the form of small separate sheets or valley glaciers. No proofs of its work have been found above 1,000 feet; and Dr. Fernald has shown that the ice-free tablelands made refuges for plants, so that many cordilleran species and more than eighty related endemic species, developed during the long interglacial period, still survive there.

There is good reason to believe that the southeastern parts of Labrador, as well as the Torngat tableland in the northeast, were not reached by the Labrador ice sheet in the Wisconsin refrigeration, which was much less severe than the earlier one, from which it was separated by a long interglacial time of milder conditions.

In the western part of the island changes of sea-level followed each of the glaciations, corresponding in amount to the thickness of the ice removed and in accord with the theory of isostasy.

The causes of the movements of sea-level in the region have been ably discussed by Daly in "Postglacial Warping of Newfoundland and Nova Scotia," and it is not necessary to take up that very interesting subject here.

The conclusions reached in regard to the glaciation of Labrador and Newfoundland throw light also on the interpretation of Pleistocene events in Nova Scotia, separated from the island only by Cabot Strait.

Goldthwait, in his excellent and very readable "Physiography of Nova Scotia," describes the glacial features of the province and suggests that there is no clear evidence of a recurrence of ice sheets during the glacial period. He has so thoroughly studied the Pleistocene of Nova Scotia

and has so well described the work of ice in that area that one hesitates to oppose his views; but one can hardly help the conclusion that his account of the surface features of the tablelands of Cape Breton Island accords much better with the theory of two glaciations than with a single glaciation, if indeed the higher parts were ever glaciated at all. He described the granite surface as cracked into angular blocks and crumbling into sharp-edged grains of sand; and there are no foreign bowlders found among the weathered débris. There are no striated surfaces on the tableland itself, though striae occur on lower ground near by.

Visits paid by myself to the Mabou tableland near Inverness and to Ingonish Mountain left a strong impression that these elevated regions had never been ice-covered. If ice ever crossed them it must have done so in a very early stage of the Pleistocene.

Fresh bowlder clay with many striated stones can be seen up to about 500 feet on Mabou Mountain, making a striking contrast with the surface above this, where there are loose blocks in place and no sign of ice work was observed. There is an even stronger contrast between the tableland at Ingonish, without a hint of glaciation, and the features of North Sydney, where one finds till with many striated stones and also well-striated surfaces of sandstone under bowlder clay along the railway a mile or two in the direction of Sydney.

The latter features are so fresh that they must be considered Wisconsin; while, if the tableland was ever ice-covered, it must have been at the very beginning of the Pleistocene, so that its effects have been removed by long-continued weathering.

This view is supported by Dr. Fernald's botanical researches, since he finds that some of the cordilleran plants observed in Gaspé and the Long Range occur also on northern Cape Breton Island. It appears, therefore, that all the highlands surrounding the Gulf of St. Lawrence, whether in Gaspé, Cape Breton, or Newfoundland, escaped the Wisconsin glaciation entirely, and in parts were not invaded even by the more extensive ice sheet of the early Pleistocene. They were nunataks not covered by the ice, and served as refuges for species of plants which were destroyed by the Wisconsin glaciation on lower ground. The botanical evidence that plant growth was little, or not at all, interrupted on the high tablelands during the ice age strongly confirms the conclusions reached by a study of the Pleistocene as described in the foregoing paper.

Up to the present there has been very little evidence to show that Eastern North America was invaded more than once by ice. On Long Island the Wisconsin drift sheet rests on two older ones, as noted by Goldthwait; and in New Jersey a very old sheet of till has been recognized; but no general and complete removal of the ice with an important interglacial time has been suggested. The evidence of two glaciations of Newfoundland and Labrador, separated by a long period of weathering, brings the Pleistocene history of the Gulf of St. Lawrence region into line with that of central Ontario, the states of the Mississippi Valley, and the cordilleran region of British Columbia, Washington, and Montana. It is evident that the so-called "ice age" was interrupted at least once by a removal of the ice sheets from the whole of North America; and it is probable that this long and warm interglacial period was world-wide.

The age of the early glaciation cannot be positively determined, since the only interglacial fossils found are Marine shells of still living species,

which are not known from other interglacial deposits. Since the earlier drift sheet is profoundly weathered, a long time of exposure must have separated it from the fresh tills of the Wisconsin; and it has been assumed that the early glacial features correspond to the Kansan or Jerseyan glaciation.[1]

This newer interpretation, that the tablelands of Newfoundland were either unscathed in the Pleistocene or were crossed only in the earliest (Kansan or Jerseyan) stage and not by a Wisconsin sheet, at once opens the way for a closer correlation of the Coastal Plain plant-migration with the demands of Douglas Johnson's conclusions regarding the depression of the banks: that they were depressed in late Tertiary or earliest Pleistocene, not in post-Wisconsin time. Instead of *Schizaea pusilla* (MAP 7) and its associates coming north to Newfoundland from New Jersey in post-Wisconsin, it now seems reasonable to visualize them either as living in Newfoundland throughout the Pleistocene or as having reached Newfoundland in pre-Wisconsin time either from the North or from the South.

Stimulated by the actual field (rather than merely desk-chair) studies of Coleman and of Johnson, I was, naturally, greatly re-impressed by the prevalence in western Newfoundland of the Coastal Plain types on the highest tablelands, where, theoretically, one would look only for boreal species; and, following the subject further, it soon became apparent that these high tablelands have long been (perhaps as far back as the Cretaceous or even the Permian) centers from which the austral element in the Newfoundland flora has radiated to the younger boggy areas of the Island, which were under early Pleistocene (Kansan?) or later Pleistocene (Wisconsin) ice. Happily, while this newer interpretation was in the process of "unconscious cerebration," I was invited to develop for an hour some theme in phytogeography before the Fifth International Botanical Congress, at Cambridge University; and, inevitably, I spoke upon the subject which was then uppermost in my mind. It is not necessary here to repeat the exposition which was published in full in RHODORA,[2] but certain points which especially concern Newfoundland may be emphasized.

The most distinctive elements of the Atlantic Coastal Plain flora of North America are members of groups which, today, are otherwise

[1] Extracts from A. P. Coleman: *The Pleistocene of Newfoundland*, Journ. Geol. xxxiv. 193–223 (1926).

[2] *Specific Segregations and Identities in some Floras of Eastern North America and the Old World*, RHODORA, xxxiii. 25–63 (1931).—Contrib. Gray Herb. xciii., especially pp. 33 et seq.

chiefly confined to the Tropics or to the Southern Hemisphere, including Australia (the *Xyridaceae*,[1] *Diospyros*, the *Halorrhageae*, *Lycopodium carolinianum*, the *Burmanniaceae*, *Drosera*, excluding a few boreal species of § *Rossolis*, etc.); some with great development in the Malayan or the Australian region (or both) but highly localized or wanting in Africa (*Schizaea*, the *Haemadoraceae*, the *Conostylideae*, *Nyssa*); to which, of course, many others could be added. In the Cretaceous (or even in the Carboniferous, in case of some of the Cryptogams) members of the *Schizaeaceae*, *Diospyros* and *Nyssa* (to say nothing of ubiquitous *Lycopodium*) abounded in the Arctic. Thence they spread southward until, due to many Tertiary and later vicissitudes in Eurasia, they were isolated in the Malayan and Australian (and sometimes the tropical or southern African) regions. With Australia severed from its northern connection in the Cretaceous, it is obvious that the eastern American remnants of these and associated groups are very ancient. The great tablelands of Newfoundland are the counterparts of the high Appalachian tablelands of continental North America, the uplifted Cretaceous Peneplane, which, worn down by long erosion-cycles, had, at the opening of Cretaceous time, been reduced essentially to sea-level, where it formed a low plain with sluggish drainage (like the present but geologically youthful Coastal Plain), with Cretaceous seas bounding it to the East, South and West. Only at the North did the baselevelled Appalachian core have a land-connection. That was when the vast northern lands, Laurentia, Baltica and Angara, formed the greater land-mass of the world, with the smaller Amazonia, Ethiopia, Lemuria and Australia separated from the northern continent by extensive seas. Briefly, then, the thesis developed at Cambridge, based largely upon the Newfoundland observations of 1926 and 1929, was, that the baselevelled Appalachian land received the southward-moving plants and that, as the late Cretaceous and Tertiary uplifts carried the Peneplane higher and higher, many species of the primitive sandy and peaty or aquatic habitats died out or found a younger haven in the sands, peats and sluggish waters of the newer Coastal Plain or in the sands, peats and pools which resulted from Pleistocene glaciation. By this newer interpretation, therefore, it is possible to coördinate the presence of these austral types on the uplifted Cretaceous Peneplane of Newfoundland with the findings of Coleman, that on some

[1] Maps of the world-ranges of the groups here noted will be found in the paper above cited.

of the tablelands of western Newfoundland, such as that of Blomidon, "there was no evidence of glaciation," and with the probability pointed out by Johnson, that, instead of being very recent, the submergence of the continental shelf was "at least post-Miocene, and more probably post-Pliocene." The exact time of interchange along the now submerged Tertiary shelf is still not quite clear; that it could have been as early as late-Tertiary now seems fairly settled, though it is as likely to have been in post-Kansan, in the long interglacial epoch (of hundreds of thousands of years) prior to the comparatively trivial Wisconsin glaciation.[1]

(To be continued)

ECTOCARPUS PARADOXUS IN NEW ENGLAND.—It is my pleasure to record the occurrence of *Ectocarpus paradoxus*, Mont., not heretofore recognized in North American waters. It may be merely a waif brought to us by the currents which come to our shores, via Greenland, from Western Europe. But likely it is sparingly established, and has been overlooked by such careful collectors as Drs. Collins and Farlow. It is at home in the Mediterranean, but occurs as far north as Scandinavia (*Kjellman*), whence our specimens probably have migrated. Careful search may reveal it in the warmer waters of New England, where it will be found occasionally intermingled with other algæ.

It has been figured several times. But the most available illustration is in the second edition of Oltmanns, *Morphologie* etc., vol. 2, pp. 10 and 11, where may be found a reproduction of drawings by the lamented Dr. Paul Kuckuck. We may add that these were to appear in a book on the brown algæ, to be issued from the press of Gustav Fischer in Jena. But the death of Dr. Kuckuck, in 1918, left unfinished this monumental work, which was also to treat some of our American forms.

The species named under the title of this note was found at Hale's Beach, North Brooklin, Maine last summer. Three microscope slides have been deposited in the National Herbarium.—R. E. SCHUH, Brooklin, Maine.

[1] This newer interpretation received strong support from evidence accumulated in the summer of 1932 in Nova Scotia, evidence so far outside the scope of the present paper that it must be considered elsewhere.